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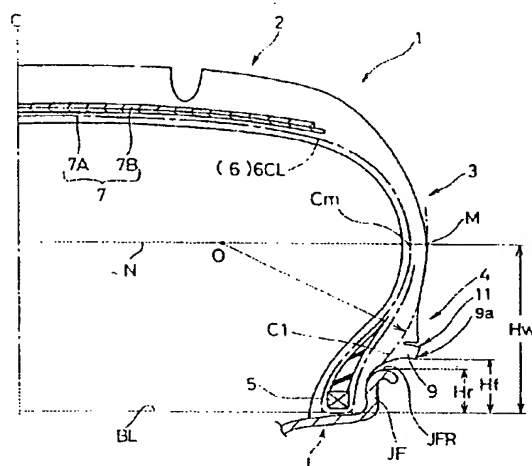
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(54) **Pneumatic tyre**

(57) A pneumatic tyre provided in at least one of sidewall portions (3) with a wheelrim protector (9) which overhangs a flange (JF) of a wheelrim and protrudes axially outwardly from the axially outer end of the flange, the wheelrim protector (9) being provided with at least one circumferential slit (11) around the axis of the tyre.

In case of a slit (11) extending continuously in the tyre circumferential direction, the slit (11) can be formed in a wedge-shaped cross sectional shape. In the case of discontinuous slits (12), the slits may be arranged around the tyre axis and inclined with respect to the adjacent carcass cords at 45 to 80 degrees.

**Fig.1**

## Description

[0001] The present invention relates to a pneumatic tyre having an improved wheelrim protector being capable of improving high speed cornering performance, ride comfort and the like.

[0002] In a pneumatic tyre having a low aspect ratio of less than 50 %, as the tyre section height is very low, the distance between the wheelrim flange and road surface is short. Therefore, there is a strong possibility that the flange contacts with curbs, objects on the ground and the like, and suffers damage therefrom.

[0003] As a technique of preventing wheelrim flanges from such damage, a wheelrim protector (d) as shown in Fig. 19 has been proposed. The protector (d) is disposed in each sidewall portion near the bead (b) and protrudes axially outwardly adjacent to the axially outmost end of the flange (jf) and extends continuously in the circumferential direction.

[0004] Such a protector increases the rubber thickness of the sidewall portion, and the flexible region of the sidewall portion is shortened. As a result, ride comfort deteriorates, and shocks received from the road surface during running are transmitted more to the bead portion and the bead durability greatly decreases.

[0005] Further, the tyre rigidity suddenly alters during cornering if there is a change from the situation where the protector does not contact the flange to the situation where the protector contacts the flange as shown in Fig.19 by a chain line. Therefore, if such a change occurs during high speed cornering it becomes difficult to control the behaviour of the car.

[0006] It is therefore, an object of the present invention to provide a pneumatic tyre having a wheelrim protector in which the ride comfort, controllability during high speed cornering and the like are improved.

[0007] According to the present invention, a pneumatic tyre comprises a tread portion, a pair of sidewall portions, a pair of bead portions, a carcass extending between the bead portions and a wheelrim protector provided in at least one of the sidewall portions so as to overhang a flange of a wheelrim when the tyre is mounted thereon protruding axially outwardly from an axially outer end of the flange, the wheelrim protector being provided with at least one circumferential slit around the axis of the tyre.

[0008] In the present invention, the circumferential slit may be a circumferentially continuous slit or discontinuous slits having such a length that the circumferential component is larger than the radial component.

[0009] Embodiments of the present invention will now be described in detail in conjunction with the accompanying drawings:

Fig.1 is a cross sectional view of an embodiment of the present invention;  
 Fig.2 is an enlarged cross sectional view showing the wheelrim protector thereof;  
 Figs.3(A) to 3(D), Figs.4(A) to 4(B), Figs.5(A) to 5(B) are schematic cross sectional views each showing another example of the slit;  
 Fig.6 is a schematic cross sectional view showing an undesirable slit;  
 Fig.7 is a cross sectional view of another embodiment of the present invention;  
 Fig.8 is an enlarged cross sectional view showing the wheelrim protector thereof;  
 Figs.9(A) to 9(C) are schematic cross sectional views for explaining a function of the slit;  
 Figs.10(A) to 10(C) are cross sectional views each showing another example of the slit;  
 Fig.11 is a cross sectional view of a slit used in comparison tests;  
 Fig.12 is a cross sectional view of another embodiment of the present invention;  
 Fig.13 is an enlarged cross sectional view showing the wheelrim protector thereof;  
 Fig.14 is a side view showing the inclination of the discontinuous slits thereof in relation to carcass cords;  
 Fig.15 is a sectional view taken along a line X-X of Fig.14;  
 Fig.16 and Fig.17 are developed views of the tread portion and sidewall portions showing the inclinations of the discontinuous slits and tread grooves;  
 Figs.18(A) to 18(C) are schematic cross sectional views for explaining a function of the discontinuous slits; and  
 Fig.19 is a cross sectional view showing a prior art wheelrim protector.

[0010] In the drawings, a pneumatic tyre 1 according to the present invention comprises a tread portion 2, a pair of sidewall portions 3, a pair of bead portions 4 each with a bead core 5 therein, a carcass 6 extending between the bead portions 4, and a belt 7 disposed radially outside the carcass 6 in the tread portion 2.

[0011] Hereinafter, various sizes or dimensions of the tyre are measured under the following normal condition if not specifically mentioned otherwise. The normal condition is that when the tyre is mounted on its standard rim and inflated to standard load but loaded with no tyre load. The standard rim is the "standard rim" specified in JATMA, the "Measuring Rim" in ETRTO, the "Design Rim" in TRA or the like. The standard pressure is the "maximum air pressure" in JATMA, the "Inflation Pressure" in ETRTO, the maximum pressure given in the "Tyre Load Limits at Various Cold Inflation Pressures" table in TRA or the like. The standard load is the "maximum load capacity" in JATMA, the "Load Capacity" in ETRTO, the maximum value given in the above-mentioned table in TRA or the like.

[0012] The carcass 6 comprises at least one ply of cords arranged radially at an angle of 70 to 90 degrees with respect to the tyre equator C.

[0013] For the carcass cords, organic fibre cords, e.g. polyester, nylon, rayon and the like are preferably used, but steel cords may be also used.

[0014] In the embodiments shown in Figs.1, 7 and 12, the carcass 6 is composed of a single ply 6A of cords arranged at 90 degrees with respect to the tyre equator C. The carcass ply 6A extends between the bead portions 4 through the tread portion 2 and sidewall portions 3 and is turned up around the bead core 5 in each of the bead portions 4 from the inside to the outside of the tyre to form a pair of turnup portion 6b and a main portion 6a therebetween.

[0015] The belt comprises a breaker 7 and optionally a band or bandage. The breaker 7 comprises at least two cross plies of parallel cords laid at narrow angles of from 10 to 45 degrees with respect to the tyre equator.

[0016] In the embodiments shown in Figs.1, 7 and 12, the breaker consists of two crossed plies 7A and 7B of steel cords.

[0017] The band (not shown) is disposed radially outside the breaker 7 and is made of spiral windings of at least one cord or at least one ply of rubberised parallel cords, wherein the cord angle is substantially zero with respect to the tyre equator. For the band cords, low elastic modulus organic fibre cords are used.

[0018] The bead portions 4 are each provided with a bead apex 8 made of hard rubber.

[0019] In the embodiments shown, the bead apex 8 is disposed between the turnup portion 6b and main portion 6a of the carcass ply 6A so as to extend and taper radially outwardly from the bead core 5.

[0020] A wheelrim protector 9 is disposed in at least one of the sidewall portions 3 which is to be located on the outside of a vehicle to which the tyre is attached.

[0021] In the embodiments shown in Figs.1, 7 and 12, each of the sidewall portions 3 is provided with a wheelrim protector 9.

[0022] The wheelrim protector 9 is defined as a portion formed near the bead portion 4 and protruding from a circular arc C1.

[0023] Under the above-mentioned normal condition, the circular arc C1 is defined as having a centre O on an axial line N passing an axially outmost point Cm of the thickness centre line 6CL of the carcass main portion; passing through a point M on the outer surface of the tyre at the same radial height as the point Cm; and circumscribing a curved surface JFR of a flange JF of a standard wheelrim J.

[0024] The protector 9 is made of hard rubber having excellent resistance to wear and abrasion. The protector 9 can be formed by utilising a sidewall rubber disposed axially outside the carcass to define the sidewall portion. However, it is also possible to form the protector by utilising a so called clinch rubber disposed along the surface of the bead portion to contact with the wheelrim as shown in Figs.7 and 12.

[0025] The wheelrim protector 9 has a profile comprising a middle part 13, a radially inside part 14, and a radially outside part 15, wherein the middle part 13 is substantially flat, and the inside part 14 and outside part 15 are concavely curved to merge into the circular arc C1. The inside part 14 is spaced apart from the wheelrim flange JF.

[0026] The protector 9 has a vertex 9a in the flat part 13. The vertex 9a is a point at which the rubber thickness measured from the circular arc C1 along the normal direction thereto becomes a maximum, and this maximum thickness Tmax is set in the range of from 3 to 20 mm, preferably 4 to 20 mm, more preferably 5 to 20 mm, still more preferably 7 to 18 mm. If the maximum thickness Tmax is less than 3 mm, it is difficult to protect the rim flange. If more than 20 mm, the tyre weight excessively increases. The vertex 9a must be located axially outwards of the axially outer end of the rim flange JF.

[0027] The difference (Hf-Hr) of the radial height Hf of the vertex 9a from the radial height Hr of the wheelrim flange JF is not less than 0.5 mm, preferably not less than 2 mm, more preferably not less than 3 mm, still more preferably not less than 5 mm.

[0028] Further, the difference (Hf-Hr) is set to be not more than 0.45 times, preferably not more than 0.30 times, more preferably not more than 0.20 times the radial height Hw of the maximum carcass width point. Here, each radial height is measured from the bead base line BL. When the vertex 9a has a certain radial extent, the above-mentioned height Hf is defined as of the radially innermost position.

[0029] If the difference (Hf-Hr) is less than 0.5 mm, tyre bead unseating is liable to occur and the mounting operation is difficult. If the difference (Hf-Hr) is more than 0.45 times the height Hw, it becomes difficult to protect the rim flange.

[0030] Fig.1 shows a first embodiment according to the present invention which is a passenger car tyre having an aspect ratio of not more than 65 %.

[0031] The carcass 6 comprises at least one ply of cords arranged radially at an angle of 70 to 90 degrees with respect to the tyre equator C.

[0032] The breaker 7 comprises at least two cross plies of parallel cords laid at narrow angles of from 10 to 45 degrees with respect to the tyre equator.

[0033] In this embodiment, the wheelrim protector 9 is provided with one slit 11 extending continuously in the circumferential direction.

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[0034] The slit 11 has a depth  $d$  of not less than 2.5 mm and not more than 0.5 times the length  $L$  of the protector 9 measured along the circular arc  $C1$ .

[0035] Preferably, the depth  $d$  is not less than 4 mm and not more than 0.3 times the protector length  $L$ .

[0036] It is necessary that the bottom of the slit 11 does not reach the circular arc  $C$ . If it reaches the circular arc  $C1$ , an essential durability is lost.

[0037] Preferably, the sectional area  $S_g$  of the slit 11 is set in the range of 5 to 43 %, preferably 10 to 43 %, more preferably 15 to 43 % of the overall sectional area  $S_f$  of the protector. The overall sectional area  $S_f$  is defined between the circular arc  $C1$  and the outer surface of the tyre, including the groove sectional area  $S_g$ . In case a plurality of slits 11 are provided, the sectional area  $S_g$  means the total thereof.

[0038] Fig.4(A) and Fig.4(B) show modifications of the protector 9 shown in Fig.2, wherein the protector 9 is provided with a plurality of slits 11. The depths of the slits increase from the radially outside to the inside of the tyre. These structures can display an excellent heat radiation or dissipation effect and thus bead durability may be further improved.

[0039] If in use of the tyre the radially inside part 14 of the protector 9 comes into contact with the flange JF during cornering, as the protector 9 can be deformed around the position of the circumferential slit 11, abrupt rigidity change does not occur.

[0040] If the depth  $d$  is less than 2.5 mm or the sectional area  $S_g$  is less than 5 %, it becomes difficult to obtain a sufficient deformation of the protector 9.

[0041] If the depth  $d$  is more than 0.5 times the length  $L$  or the sectional area  $S_g$  is more than 43%, the strength of the protector 9 decreases and it becomes difficult to protect the rim flange.

### Comparison Test 1

[0042] By way of a comparison test test tyres of size 225/50R16 (Rim size: 16X7JJ) having the specifications shown in Table 1 were made and tested for rim protection, high speed cornering performance, and bead durability.

### Rim protection test

[0043] At a slow speed of 5 km/h, the test tyre was driven into a curb at an angle of 5 degrees, and after the sidewall portion came into contact with the curb, the tyre was run five metres parallel to the curb. Then, the wheelrim was checked for damage.

### High speed cornering test

[0044] A Japanese 3000cc FR passenger car provided with test tyres was run on 80R and 100R corners at high speed, and the steering stability in a transition period of cornering was evaluated by the test driver's feeling.

### Bead durability test

[0045] Using a tyre testing drum, a test tyre inflated to its normal pressure of 250 kPa was run at a speed of 60 km/h at an over load of 1512 kgf, and the running time until visible damage occurred in the bead portion was measured.

[0046] The test results are shown in Table 1, using an index based on Ref.A1 being 100. The larger the index, the better the test result.

Table 1

Type	Ex.A1 Fig.1	Ex.A2 Fig.1	Ex.A3 Fig.3(A)	Ex.A4 Fig.3(B)	Ex.A5 Fig.3(C)	Ex.A6 Fig.5(A)	Ex.A7 Fig.4(B)	Ex.A8 Fig.4(A)	Ex.A9 Fig.5(B)	Ex.A10 Fig.3(D)	Ex.A11 Fig.3(A)	Ex.A12 Fig.3(D)	Ref.A1 Fig.19	Ref.A2 Fig.19	Ref.A3 Fig.19	Ref.A4 Fig.6	Ref.A5 Fig.3(A)
Silt	1	1	1	1	1	1	3	7	3	1	1	3	0	0	0	1	1
Number on each side	43	18.5	23	23	23	23	23	23	23	23	23	23	23	45	18	23	23
Vertex height Hf (mm)	25	0.5	5	5	5	5	5	5	5	5	5	5	5	27	0	5	5
Hf-Hr (mm)	0.45	0.01	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.49	0	0.09	0.09
(Hf-Hr)/Hw	4	20	7	7	7	7	7	7	7	7	7	7	7	4	20	7	7
Maximum thickness Tmax(mm)	4	7	7	7	25	14	9	12	5	1	7	9	-	-	-	10	16
Depth d (mm)	4	7	7	7	0.05	0.14	0.43	0.39	0.2	0.05	0.03	0.5	-	-	-	0.05	0.15
Sg/Sf	0.17	0.17	0.17	0.05	0.05	0.14	0.43	0.39	0.2	0.05	0.03	0.5	-	-	-	0.05	0.15
Rim protection	100	100	100	100	100	100	99	100	100	100	100	98	100	100	100	100	100
High speed cornering performance	116	114	116	106	108	110	116	112	109	106	102	117	100	100	100	114	110
Bead durability	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100	80	100

Flange height Hr = 18mm, Maximum carcass width height Hw = 55mm

[0047] The following points can be seen:-

- Fig.3(A): The circumferential slit 11 is wider than that in Fig.1.
- Fig.3(B): The circumferential slit 11 is narrower than that in Fig.1.
- 5 Fig.3(C): The circumferential slit 11 has a rectangular sectional shape.
- Fig.3(D): The circumferential slit 11 has a width larger than the depth.
- Fig.5(A): The protector 9 is provided with a circumferential slit 11 extending from the radially outside part 15 of the protector 9 towards the radially inside.
- Fig.5(B): The protector 9 is provided with a plurality of slits 11 extending from the radially inside part 14 of the protector 9 towards the radially outside.
- 10 Fig.6: The circumferential slit 11 extends over the circular arc C1.

[0048] From the test results, it was confirmed that Example tyres were improved in rim protection and high speed cornering stability.

#### Second embodiment

- [0049] Fig.7 shows a second embodiment according to the present invention which is a passenger car tyre having an aspect ratio of not more than 50 %. (in this example 45%)
- 20 [0050] The carcass 6 comprises at least one ply of cords arranged radially at an angle of 75 to 90 degrees with respect to the tyre equator C.
- [0051] The breaker 7 comprises at least two cross plies of parallel cords laid at narrow angles of from 10 to 40 degrees with respect to the tyre equator.
- 25 [0052] The wheelrim protector 9 is provided in the middle part 13 with at least one slit 11 extending continuously in the circumferential direction.
- [0053] In this embodiment, the slit 11 has a wedge-shaped cross sectional shape, and thus, the width gradually decreases from the top to the bottom of the slit.
- [0054] The distance D between the bottom 11B of the slit 11 and the adjacent carcass ply cords is not less than 2 mm, preferably more than 2 mm, but preferably not more than 5.0 mm.
- 30 [0055] If the distance D is less than 2 mm, a crack reaching to the carcass cords is liable to occur at the groove bottom 11B, and the tyre durability is greatly decreased.
- [0056] As to the groove walls of the slit 11, it is preferable that the radially outer wall 11o is substantially straight, but the radially inner wall 11i is convexly curved, as shown in Fig.8. In this example, the radius of curvature R thereof is about 10 mm.
- 35 [0057] In Fig.10(B), by contrast, the outer groove wall 11o is convexly curved, and the inner groove wall 11i is straight. This structure is also preferable.
- [0058] As a result, as the load on the tyre increases, the inner and outer groove walls 11i and 11o contact each other, and the contact area gradually increases. Thus, the tyre rigidity gradually increases. Therefore, abrupt changes in the tyre characteristics during cornering are avoided to improve the controllability.
- 40 [0059] Further, as shown in Fig.10(C), it is also possible that both the inner and outer groove walls 11i and 11o are convexly curved.
- [0060] Furthermore, it is also possible that both the inner and outer groove walls 11i and 11o are straight as shown in Fig.10(A).
- 45 [0061] As to the width of the slit 11, it is preferable that, when a side force is applied to the tyre which is mounted on a standard wheelrim and inflated to a standard inner pressure and loaded with a standard load, the top of the slit does not close until the side force reaches 1.8G at least. In this embodiment, thus, the slit width at the top is set in the range of from 2 to 5 mm, more preferably 2 to 4 mm. (in this example 3 mm)
- [0062] The depth of the slit 11 may be set in the range of from 6 to 10 mm. (in this example 7 mm)
- 50 [0063] Preferably, the bottom of the slit 11 is rounded by an arc having a radius of 0.5 to 1.0 mm to prevent stress concentration.
- [0064] In a tyre meridian section, the centre line of the slit 11 in this embodiment extends along a normal direction to the circular arc C1. However, it is also possible to extend along another direction for example the axial direction of the tyre.
- 55 [0065] Therefore, when the vertical load is applied, as the protector 9 can be deformed due to the slit, the ride comfort is good.
- [0066] During cornering, if the sidewall portion on the outside of the vehicle is deformed from the situation shown in Fig.9(A) to the situation shown in Fig.9(B) and the protector 9 comes into contact with the rim flange JF, as the slit having a certain width is present, the protector 9 can be further deformed whilst the slit width decreases as shown in

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Fig.9(C). Thus, dangerous abrupt rigidity change is avoided.

### Comparison test 2

- 5 [0067] Test tyres of size 215/45R17 (Rim size: 17X7.0JJ) were made and tested for the ride comfort, steering stability, bead durability, tyre weight

### Ride comfort test and Steering stability test

- 10 [0068] A test car provided on all four wheels with test tyres was run on a dry asphalt paved road surface of a tyre test course. Based on the test driver's feeling, harshness, push-up, damping and the like were evaluated as the ride comfort, and further controllability and the like at a critical cornering speed was evaluated as the steering stability. The results are indicated by an index based on Prior Art tyre being 100. The larger the index, the better the performance.

### Bead durability test

- 15 [0069] Using a tyre testing drum, the test tyre inflated to 300 kPa was run at a speed of 60 km/h under over load of 10.07 kN, and the running time until visible damage was caused in the bead portion was measured. The results are indicated by an index based on Prior Art tyre being 100. The large the index, the better the durability.

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### Tyre weight

- [0070] The tyre weight is indicated by an index based on Prior Art tyre being 100. The smaller the index, the lighter the tyre weight.
- 25 [0071] The test results are shown in Table 2.

Table 2

Tyre	Prior	Ex.B1	Ex.B2
Slit			
Shape	Fig.11	Fig.10(A)	Fig.8*
Top width (mm)	1	3	3
Depth (mm)	7	7	7
Ride comfort	100	130	130
Steering stability	100	115	120
Bead durability	100	130	130
Tyre weight	100	99	99

\*) R=10.0mm

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[0072] From the test results, it was confirmed that Example tyres can be improved in the ride comfort and controllability.

[0073] Fig.12 shows a third embodiment of the present invention which is a passenger car tyre having an aspect ratio of not more than 50 %. (in this example 45%)

- 45 [0074] The carcass 6 comprises at least one ply of cords arranged radially at an angle of 75 to 90 degrees, preferably 80 to 90 degrees with respect to the tyre equator C.

[0075] The breaker 7 comprises at least two cross plies of parallel cords laid at narrow angles of from 10 to 40 degrees with respect to the tyre equator.

[0076] In this embodiment, the wheelrim protector 9 is provided with a plurality of slits 12.

- 50 [0077] The slits 12 are arranged around the tyre axis at regular angle pitches.

[0078] The number of the slits 12 on each protector 9 is set to be not less than 5, preferably not less than 10, more preferably not less than 20.

[0079] As shown in Fig.15, every slits 12 extends from the radially outside part 15 to the radially inside part 14 across the protector 9.

- 55 [0080] As shown in Fig.14, the slits 12 on each protector 9 are inclined to the circumferential direction at an angle  $\theta$  of from 45 to 80 degrees, preferably 45 to 70 degrees, with respect to the adjacent carcass cords 6C (in this example the cords of the carcass ply turnout portion 6b). As a result, directional rigidity is provided in the lower sidewall portion

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and the steering stability is improved.

[0081] In this example, along the tyre circumferential direction, the slits 12 overlap each other in their circumferential end portions. Such overlaps are however not always necessary.

[0082] The width of the slits 12 is not less than 0.5 mm, preferably 0.5 to 3.0 mm, more preferably 0.5 to 2.0 mm, still more preferably 0.5 to 1.5 mm.

[0083] The distance D from the bottom 12B of the slits 12 to the adjacent carcass cords is not less than 2.0 mm, preferably 2.0 to 5.0 mm.

[0084] The depth of the slits 12 is 6 to 10 mm. (in this example about 7 mm)

[0085] Preferably, the bottom 12B of the slits 12 is rounded by an arc having a radius of 0.5 to 1.0 mm to prevent cracking.

[0086] If the angle is less than 45 degrees or the width is less than 0.5 mm, it becomes difficult to obtain a sufficient deformation of the protector 9. If the angle is more than 80 degrees, the steering stability is liable to decrease. If the distance D less than 2.0mm, durability greatly decreases.

[0087] In Fig.16, the tyre is provided with tread grooves 20 defining a directionally bound tread pattern T1, and the slits 12 on both sides of the tyre are inclined in one circumferential direction. Thus, in the developed view, the slits 12 are symmetrical about the tyre equator C. In this example, the inclining direction of the slits 12 is equal to the designed rotating direction of the tyre which is usually indicated in the sidewall portions. By inclining in this way, a full bead reinforcing effect can be obtained by the protector 9, and a rigidity balance between the two bead portions can be kept, and excellent steering stability is obtained.

[0088] In Fig. 17, the tyre is provided with tread grooves 21 defining a bi-directional tread pattern T2, and the inclining direction of the slits 12 on one side of the tyre is reversed to that on the other side. Thus, in the developed view, the slits 12 are arranged symmetrically about finite number of points on the tyre equator C.

[0089] In any case (Fig.16 or Fig.17), in each half on one side of the tyre equator, the inclining direction of the slits 12 is the same as the inclining direction of the axial grooves (20, 21).

[0090] In the above-mentioned examples, the slits are straight, but they can be curved.

[0091] The slits 12 decrease the rigidity of the wheelrim protector 9 and make it easier to deform the protector 9 when vertical load is applied. Thus, the ride comfort is improved.

[0092] During cornering, if the sidewall portion on the outside of the vehicle is deformed from the situation shown in Fig.18(A) to the situation shown in Fig.18(B) and the protector 9 comes into contact with the rim flange JF, the slit opens. The side force to the tyre is further increased, the slit width again decreases as shown in Fig.18(C). As a result, a dangerous abrupt rigidity change can be avoided.

### Comparison test 3

[0093] Test tyre of size 215/45R17 having specifications shown in Table 3 were made and tested for the ride comfort, steering stability, and bead durability.

### Ride comfort, Steering stability and Bead durability tests

[0094] Same is above

[0095] The results are indicated in Table 3 by an index based on Prior Art tyre being 100.

Table 3

Tyre	Prior	Ref.C1	Ref.C2	Ex.C1	Ex.C2
Slit					
Number on each side	0	30	30	30	30
Width (mm)		0.3	0.5	0.5	0.5
Angle $\theta$ (deg)		70	40	70	45
Distance D (mm)		3	3	3	3
Ride comfort	100	105	103	110	105
Steering stability	100	100	95	103	101
Bead durability	100	115	100	120	110

[0096] From the test results, it was confirmed that Example tyres were improved in ride comfort, steering stability, and bead durability.



Claims

1. A pneumatic tyre comprising a tread portion (2), a pair of sidewall portions (3), a pair of bead portions (4), a carcass (6) extending between the bead portions, characterised by a wheelrim protector (9) provided in at least one of said  
5 sidewall portions so as to overhang a flange (JF) of a wheelrim (J) when the tyre is mounted thereon protruding axially outwardly from an axially outer end (JFR) of the flange, said wheelrim protector being provided with at least one circumferential slit (11,12) around the axis of the tyre.
2. A pneumatic tyre according to claim 1, characterised in that the wheelrim protector (9) protrudes from a circular  
10 arc (C1), the circular arc (C1) having a centre on an axial line (N) passing through maximum section width points of the carcass (6), and passes through a point M on the outer surface of the tyre at the same radial height as the maximum section width points of the carcass (6), and circumscribes the flange (JF) of the wheelrim.
3. A pneumatic tyre according to claim 2, characterised in that the wheelrim protector (9) has a vertex (9a) which  
15 defines a maximum thickness Tmax of 3 to 20 mm, the thickness Tmax being measured from the surface to the circular arc (C1) in the normal direction thereto, the difference (Hf-Hr) of the radial height Hf of the vertex (9a) from the radial height Hr of the rim flange is not less than 0.5 mm and not more than 0.45 times the radial height Hw of the maximum width point of the carcass (6), each radial height being measured from a bead base line BL.
4. A pneumatic tyre according to claim 1, 2, or 3, characterised in that said at least one circumferential slit (12) is a  
20 single slit extending continuously in the tyre circumferential direction.
5. A pneumatic tyre according to claim 1, 2 or 3, characterised by a plurality of slits (11) extending continuously in  
25 the tyre circumferential direction.
6. A tyre according to claim 1, 2, 3, 4 or 5, characterised in that the depth of the slit (11) is not less than 2.5 mm.
7. A tyre according to claim 2, 3, 4 or 5, characterised in that the bottom of the slit (11) does not reach the circular  
30 arc (C1).
8. A tyre according to claim 2, 3, 4 or 5, characterised in that the depth of the slit (11) is not more than 0.5 times an  
extent L of the wheelrim protector measured along the circular arc C1.
9. A tyre according to claim 2, 3, 4 or 5, characterised in that the total sectional area Sg of said at least one circum-  
35 ferential slit (11) is 5 to 43 % of the overall sectional area Sf of the wheelrim protector.
10. A tyre according to claim 1, 2, 3, 4 or 5, characterised in that in a tyre meridian section, said plurality of slits (11)  
are inclined in the substantially same direction with respect to the axial direction of the tyre.
- 40 11. A pneumatic tyre according to claim 1, characterised in that said at least one circumferential slit (11) extends continuously in the circumferential direction of the tyre, and in a meridian section of the tyre, the width of the slit (11) gradually decreases from the top to the bottom thereof to have a wedge-shaped cross sectional shape, and the distance from the bottom of the slit to the carcass cords is at least 2 mm.
- 45 12. A pneumatic tyre according to claim 11, characterised in that the slit (11) has a radially inner wall (11i) and a radially outer wall (11o), and in a meridian section of the tyre, one of the inner wall (11i) and outer wall (11o) is convexly curved, and the other is convexly curved or substantially straight.
- 50 13. A pneumatic tyre according to claim 1, characterised in that said carcass comprising a ply of cords (6) arranged radially of the tyre, said at least one circumferential slit (11) is a plurality of slits (12) disposed around the tyre axis and inclined to one circumferential direction at an angle of 45 to 80 degrees with respect to the adjacent carcass cords, the width of the slits (12) is at least 0.5 mm, and the distance from the bottom of the slits to the carcass cords (6) is not less than 2.0 mm.
- 55 14. A pneumatic tyre according to claim 13, characterised in that said tread portion is provided with tread grooves (20) defining a directionally bound tread pattern, said wheelrim protector with said a plurality of slits (12) is provided on each side of the tyre, and all the slits (12) on both sides of the tyre are inclined to the same circumferential direction.

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- 15.** A pneumatic tyre according to claim 13, characterised in that said tread portion is provided with tread grooves (21) defining a bi-directional tread pattern, said wheelrim protector with said a plurality of slits (12) is provided on each side of the tyre, and the slits (12) on one side of the tyre are inclined reversely to the slits on the other side.

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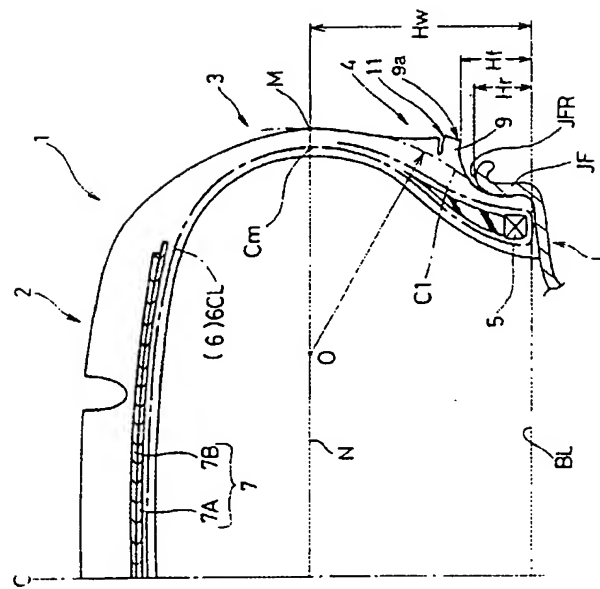
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**Fig. 1**

Fig.2

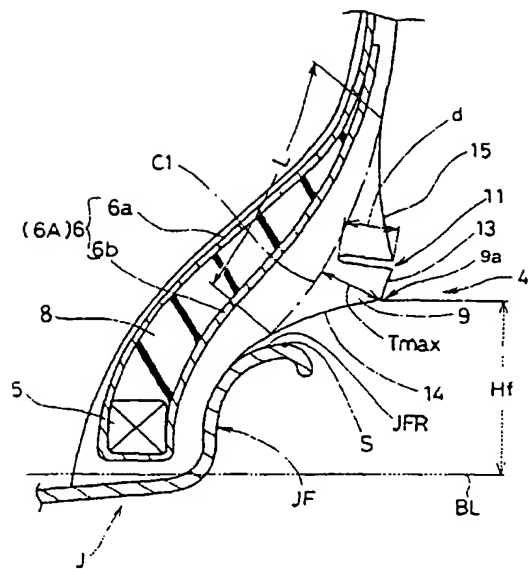


Fig.3(A)

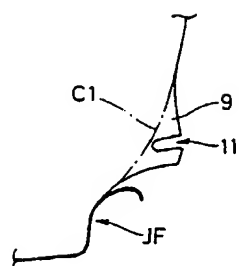


Fig.3(B)

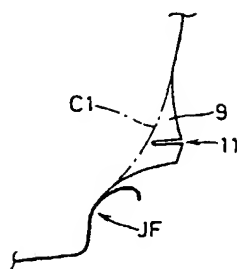


Fig.3(C)

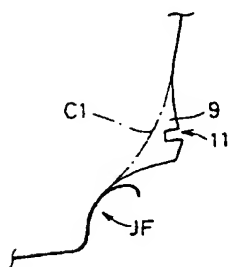


Fig.3(D)

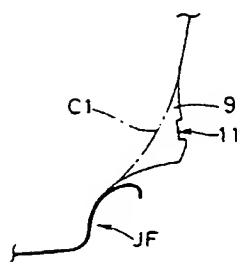


Fig.4(A)

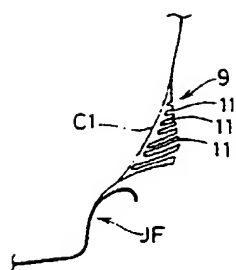


Fig.4(B)

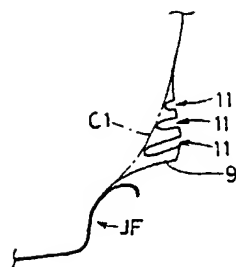


Fig.5(A)

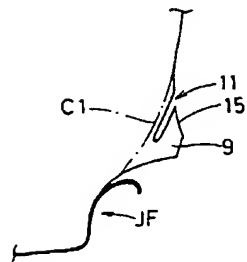


Fig.5(B)

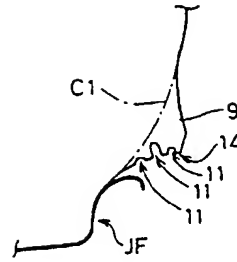
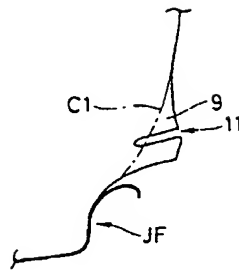


Fig.6



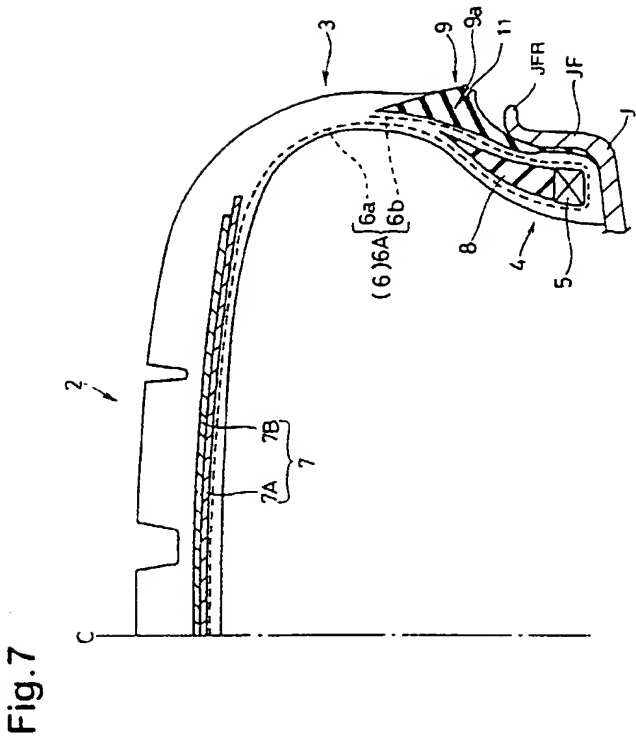




Fig.8

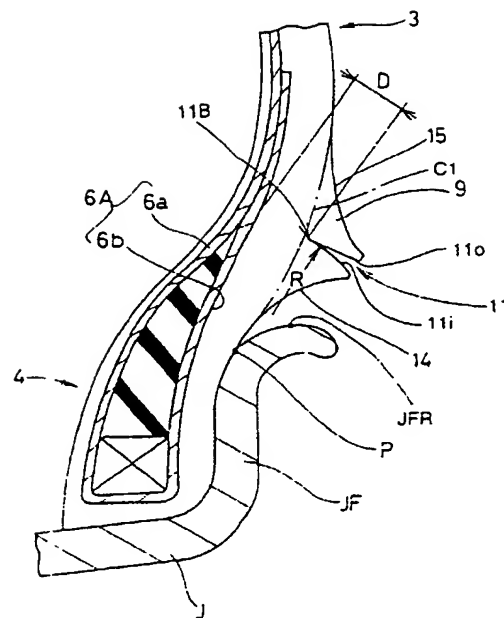


Fig.9(A)

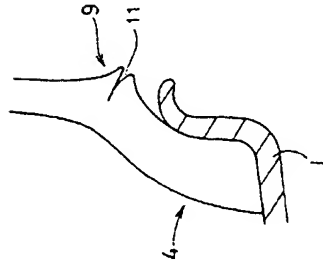


Fig.9(B)

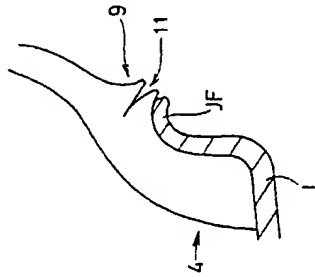


Fig.9(C)

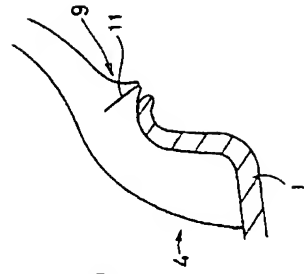


Fig.10(A)

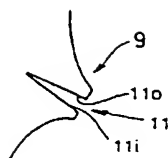


Fig.10(B)

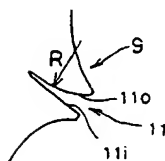


Fig.10(C)

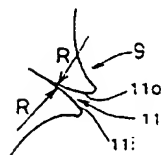
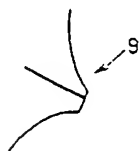


Fig.11



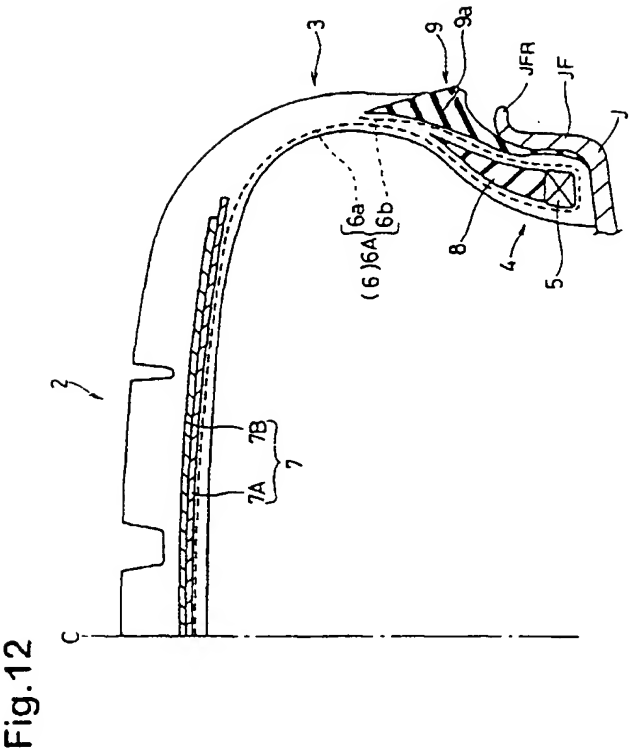


Fig.13

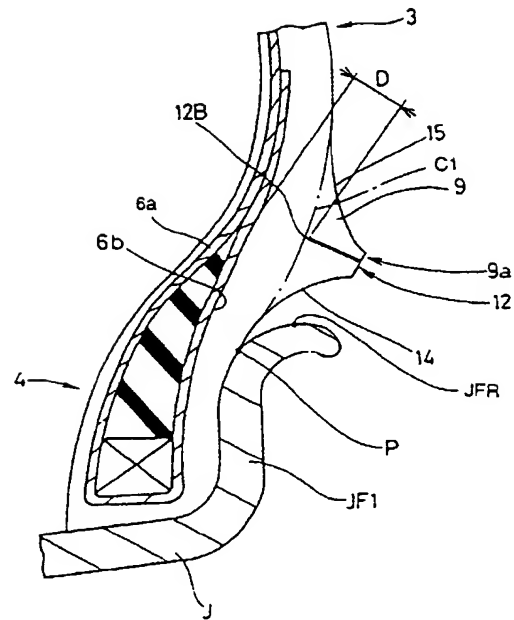


Fig.14

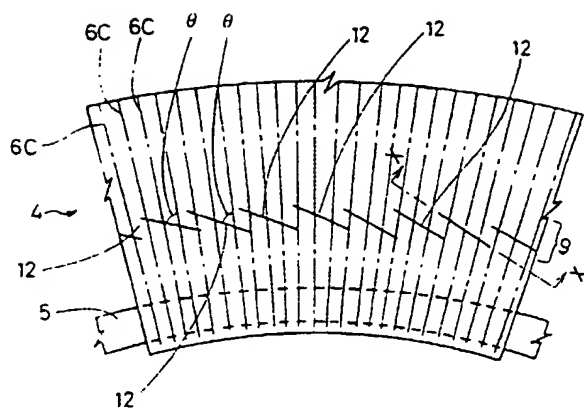


Fig.15

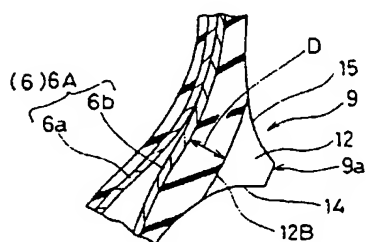


Fig.16

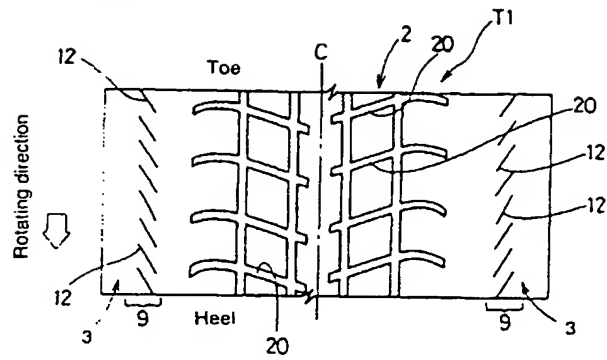


Fig.17

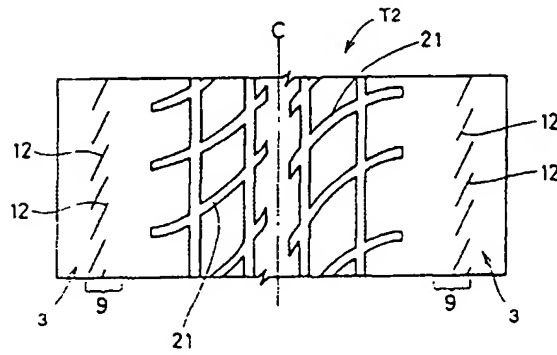


Fig.18(A)

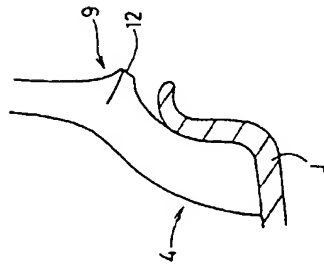


Fig.18(B)

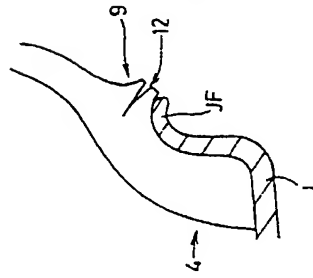
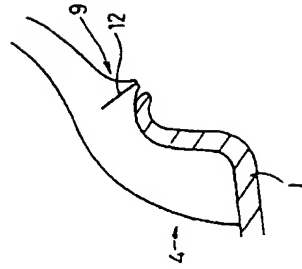


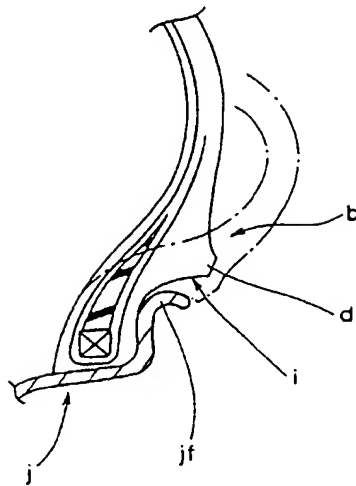
Fig.18(C)

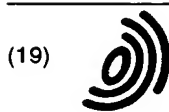




**Fig.19**

Prior Art





Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 0 983 875 A3**

(12)

## EUROPEAN PATENT APPLICATION

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24.10.2001 Bulletin 2001/43

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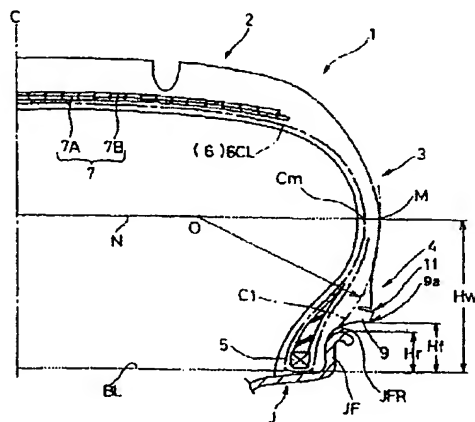
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### (54) **Pneumatic tyre**

(57) A pneumatic tyre provided in at least one of sidewall portions (3) with a wheelrim protector (9) which overhangs a flange (JF) of a wheelrim and protrudes axially outwardly from the axially outer end of the flange, the wheelrim protector (9) being provided with at least one circumferential slit (11) around the axis of the tyre.

In case of a slit (11) extending continuously in the tyre circumferential direction, the slit (11) can be formed in a wedge-shaped cross sectional shape. In the case of discontinuous slits (12), the slits may be arranged around the tyre axis and inclined with respect to the adjacent carcass cords at 45 to 80 degrees.

**Fig.1**





European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 30 6822

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 02, 28 February 1997 (1997-02-28) -& JP 08 282218 A (BRIDGESTONE CORP), 29 October 1996 (1996-10-29) * abstract; figures 1,2 *	1,3,5, 8-11	B60C13/02 B60C15/024
X	US 4 308 907 A (MONZINI RENATO) 5 January 1982 (1982-01-05) * column 6, line 3 - line 9; figures 1,2 *	1,3,5,6, 9-11	
X	US 4 057 092 A (TRACY FRANK R) 8 November 1977 (1977-11-08) * column 4, line 48 - column 5, line 16; figures 8,9 *	1,5,6,9, 10	
A	FR 1 427 189 A (KLÉBER) 20 April 1966 (1966-04-20) * page 2, left-hand column, line 21 - line 28 * * page 2, right-hand column, line 3 - line 7; figures *	1,4-6, 9-11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B60C
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
MUNICH		27 August 2001	Peschel, W
CATEGORY OF CITED DOCUMENTS			
<p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  I : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03 82 (P01C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 30 6922

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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27-08-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 08282218 A	29-10-1996	NONE	
US 4308907 A	05-01-1982	IT 1166629 B	05-05-1987
		IT 1061136 B	20-10-1982
		IT 1065011 B	25-02-1985
		AU 512303 B	02-10-1980
		AU 2595777 A	14-12-1978
		BR 7704026 A	28-03-1978
		CA 1090850 A	02-12-1980
		DE 2725856 A	05-01-1978
		ES 460085 A	01-10-1978
		FR 2355679 A	20-01-1978
		GB 1582034 A	31-12-1980
		IN 147348 A	09-02-1980
		JP 53000501 A	06-01-1978
		SE 7707233 A	24-12-1977
		US 4168732 A	25-09-1979
US 4057092 A	08-11-1977	NONE	
FR 1427189 A	20-04-1966	BE 673798 A	01-04-1966
		LU 50143 A	24-02-1966
		NL 6516406 A	24-06-1966